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Prevalence and associated factors of multidimensional poverty among rural households in West Gojjam Zone, northern Ethiopia: a household-based cross-sectional study

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Abstract

Background Multidimensional poverty, encompassing deprivations in education, health, and living standards, is a significant challenge in rural Ethiopia. Despite various development initiatives, poverty remains pervasive in the West Gojjam Zone of northern Ethiopia. This study aims to assess the extent of multidimensional poverty in this region and identify key factors contributing to the likelihood of households experiencing it.

Methods A cross-sectional survey was conducted in the West Gojjam Zone, involving 628 rural households selected through a multi-stage sampling approach. Descriptive statistics were used to calculate the multidimensional poverty index (MPI), focusing on poverty incidence, gap, and severity. A binary logistic regression model was applied to examine the relationship between household characteristics and the likelihood of being multidimensionally poor.

Results The study revealed that 93.95% of households in the West Gojjam Zone experience multidimensional poverty, with an intensity of 61.17% and an adjusted multidimensional headcount ratio of 57.47%. Key factors associated with a lower likelihood of multidimensional poverty include land ownership, off-farm income, year-round road access, the frequency of agricultural extension services, and access to loans. Conversely, the age of household heads is positively associated with an increased likelihood of poverty, with older household heads being more vulnerable.

Conclusions The findings highlight that multidimensional poverty in the West Gojjam Zone is primarily driven by limited access to land, financial services, infrastructure, and agricultural support. Furthermore, older household heads are particularly at risk. To address these challenges, the study recommends policies that focus on enhancing agricultural productivity, expanding access to financial services, improving road infrastructure, and fostering non-farm income-generating activities. Strengthening agricultural extension services is essential to enhancing household resilience and reducing poverty.

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Introduction

Multidimensional poverty, defined as deprivation in multiple dimensions such as income, education, healthcare, living standards, and access to essential services, remains a persistent issue in rural Ethiopia [1, 2]. Despite various development interventions, regions like West Gojjam continue to exhibit high poverty levels. This is primarily attributed to inadequate infrastructure, limited healthcare access, poor educational opportunities, and a dependence on subsistence agriculture [3, 4].

While several studies have explored the socio-economic determinants of poverty in Ethiopia, including household size, dependency ratio, education level, gender of the household head, access to credit, and off-farm income [5–15], the role of the household head's age in shaping multidimensional poverty remains underexplored, particularly in the context of West Gojjam. Although a prior study in East Gojjam incorporated age as a variable in its poverty analysis [15], its findings may not fully generalize to West Gojjam due to socio-economic differences. Additionally, the three-year gap between that study (2020) and the current research (2023) necessitates an updated and localized analysis.

The age of the household head is a significant factor influencing access to resources, decision-making capabilities, and resilience to economic shocks [16–19]. However, most previous research has relied on aggregated community-level data, which can obscure intra-household disparities and fail to account for individual-level dynamics influencing poverty status [20]. Furthermore, although studies across the Amhara region have identified key poverty-related factors—such as household size, gender of the household head, farm size, livestock holdings, and participation in non-farm or off-farm activities—they often overlook critical variables such as access to agricultural extension services and cultivated land size. Additionally, findings across studies remain inconsistent [3, 15, 21], highlighting the need for a more comprehensive and context-specific analysis.

This study seeks to address these gaps by examining the prevalence of multidimensional poverty in West Gojjam and identifying the socio-economic factors contributing to it. Specifically, the research will address two key questions: (1) what is the prevalence of multidimensional poverty among rural households in West Gojjam? And (2) what socio-economic factors are significantly associated with multidimensional poverty in the region?

By answering these questions, the study aims to provide updated, region-specific evidence to inform the development of targeted and effective poverty reduction strategies in West Gojjam.

Materials and methods

Study area

This study was conducted in the West Gojjam Zone, located in the Amhara Region of Ethiopia. The zone is bordered by the East Gojjam Zone to the east, the Awi Zone to the west, the North Gondar Zone to the north, and the South Gondar Zone to the northwest. Additionally, it shares borders with the Oromia Region and the Benishangul-Gumuz Region to the south. The capital of the zone, Finote Selam, is located approximately 387 km from Addis Ababa and 176 km from Bahir Dar. West Gojjam has a predominantly Amhara population (99.42%) with Amharic as the primary language (99.43%) and Ethiopian Orthodox Christianity as the dominant religion (98.68%). The total population of the zone is 2,106,596, consisting of 1,058,272 men and 1,048,324 women. The area covers 13,311.94 square kilometers, with a population density of 158.25 individuals per square kilometer. Approximately 91.23% of households are located in rural areas, with an average household size of 4.39 individuals [22].

Study design

This cross-sectional study utilized a quantitative design to assess the prevalence and determinants of multidimensional poverty among rural households in the West Gojjam Zone. The study aimed to investigate various socio-economic and demographic factors contributing to multidimensional poverty, including education, health, and living standards. The findings were intended to inform targeted interventions for poverty alleviation and improving the well-being of rural households in the region.

Data collection and quality check

Primary data were collected through a structured household survey designed to assess multidimensional poverty, based on the Oxford Poverty and Human Development Initiative (OPHI) framework (2017). The survey questionnaire is included as supplementary material to this manuscript. The survey focused on three key dimensions of poverty: education, health, and standard of living. Specific indicators included adult and child education, malnutrition, child mortality, access to clean water, sanitation, electricity, floor quality, and household assets. Data collection was carried out between January 15 and

February 15, 2023, by a team of trained enumerators to ensure the accuracy and reliability of the results.

To ensure the quality of the collected data, we implemented a series of checks throughout the process. During data collection, enumerators were closely monitored by field supervisors to ensure adherence to protocols and consistency in responses. The survey tool was pre-tested to identify and resolve potential issues before full-scale data collection began. Upon completion of data collection, data cleaning procedures were employed to check for missing values, inconsistencies, and outliers. Any errors or inconsistencies were corrected before analysis. Additionally, the data was cross-checked against established sources such as census data for validation. Descriptive statistics and visualizations were also used to identify and address any discrepancies. These measures were taken to ensure that the data collected was accurate, consistent, and relevant, providing a solid foundation for the analysis presented in this study.

Sampling procedure

The study employed a comprehensive multistage sampling technique to systematically select study participants. In the first stage, three woredas—Dega Damot, Dembecha, and South Achefer—were randomly selected from the 15 administrative woredas in the West Gojjam Zone, serving as the primary sampling units. In the second stage, each selected woreda was subdivided into kebeles—the smallest administrative units in Ethiopia—and three kebeles were randomly selected from each. In the final stage, households within the selected kebeles were chosen using a systematic interval sampling method, serving as the ultimate units of analysis.

The sample size was initially calculated based on a 50% estimated poverty rate ($p = 0.5$) to ensure the maximum sample size. Using a 95% confidence level ($Z = 1.96$) and a 5% margin of error ($E = 0.05$), the initial sample size was calculated to be 385 households. After adjusting for a 10% non-response rate, the sample size was increased to 424 households. A design effect ($Deff = 1.5$) was then applied to account for the multistage sampling design, which raised the sample size to 636 households. However, 8 households did not participate voluntarily during data collection, leading to a final sample size of 628 households.

Study variables and measurements

This study investigates multidimensional poverty using the Multidimensional Poverty Index (MPI), where the dependent variable is the multidimensional poverty status of households. A household is considered multidimensionally poor, if it's MPI score is greater than or equal to 0.33. The MPI is calculated by combining three key components: the Multidimensional Headcount Ratio (H), which measures the proportion of people whose weighted deprivations are 0.33 or more; the Intensity of Poverty (A), which reflects the average degree of deprivation experienced by the poor; and the final adjusted multidimensional headcount ratio or Multidimensional Poverty Index (MPI), which is the product of the headcount and intensity ($MPI = H \times A$). This index measures both the proportion of individuals living in poverty and the severity of deprivation across various dimensions. This study investigates the socio-economic and demographic factors affecting multidimensional poverty. Key variables include the age of the household head, divided into age groups (20–39 years, 40–59 years, and 60 years and above), land ownership (measured in hectares of cultivated land), and access to year-round roads (Yes/No). The study also examines agricultural extension services, quantified by the frequency of visits per month and year, to ensure consistent reporting, as well as off-farm income, measured in Ethiopian Birr. Access to loan services is treated as a binary variable, indicating whether loans are obtained from semi-formal and formal financial institutions (Yes/No). Additional demographic factors, such as household size, education, health status, marital status, gender, employment status, and the dependency ratio of the household head, are also included to offer a comprehensive understanding of the household's socio-economic context.

Poverty dimensions, indicators, and weights

The study adopts the multidimensional poverty framework developed by the Oxford Poverty and Human Development Initiative (OPHI), which identifies three core dimensions of poverty: education, health, and standard of living. These dimensions are further broken down into specific indicators, each with a deprivation threshold that determines whether a household is considered deprived in each dimension.

In the education dimension, two indicators are used. A household is considered deprived if any member has not completed at least 8 years of schooling (adult education). A household is also considered deprived if at least one child did not join school at age 7 (child education). In the health dimension, there are two indicators. A household is deprived if it consumes fewer than 2,100 calories per adult per day (adult malnutrition) and if any child in the household has died before the age of 5 (child mortality). The standard of living dimension includes several indicators: a household is considered deprived if it lacks access to clean water or if it takes more than 30 min to fetch water; if it uses traditional cooking energy sources such as animal dung, charcoal, or straw; if the floor is not made of cement or other modern materials; if it lacks adequate sanitation or uses a shared field; and if it owns fewer than one radio, television, cart, generator, or car.

The indicators are assigned specific weights based on OPHI guidelines from 2017. Education and health each have a weight of 1/6, reflecting their critical role in poverty assessment. The standard of living dimension, which covers material deprivations, is assigned a weight of 1/18. These weights are tailored to the context of the West Gojjam Zone, ensuring a nuanced and context-specific measure of multidimensional poverty. The approach guarantees that the MPI provides a more comprehensive understanding of poverty, including not just income but also factors like education, health, and living conditions.

Ethics approval and consent to participate The study was approved by the Research Institute Board of Debre Markos University (protocol number: DMU/4069/18/2023) on January 3, 2023. All research procedures were conducted in accordance with relevant ethical guidelines and regulations. Written informed consent was obtained from each participant prior to participation in the study. Participants were fully informed about the study's objectives, procedures, potential risks, and benefits. They were also informed of their right to withdraw from the study at any stage without any penalty.
Data Analysis.

The data analysis employed both descriptive and inferential statistical techniques. Descriptive statistics were used to calculate the Multidimensional Poverty Index (MPI), which comprises key indicators such as the multidimensional headcount ratio, the intensity of poverty, and the adjusted multidimensional headcount ratio. These measures provided a comprehensive overview of the poverty landscape within the study area. To examine the association between household characteristics and the likelihood of experiencing multidimensional poverty, a binary logistic regression model was employed. This inferential approach enabled the identification of significant socio-economic and demographic determinants of multidimensional poverty.

Binary Logistic Regression Model.

A binary logistic regression model was used to investigate the factors influencing multidimensional poverty. In this model, the dependent variable represents poverty status, coded as 1 for multidimensional poor and 0 for non-poor. The logistic model computes the probability of a household being multidimensionally poor based on explanatory variables. The model is specified as:

$$(\mathrm{Y_i} = 1) = \frac{\mathrm{e}^{\beta_0 + \mathrm{X_i}\beta_i}}{1 + \mathrm{e}^{\beta_0 + \mathrm{X_i}\beta_i}} \tag{1}$$

Where Y_i is the dependent variable (poverty status) for household i, X_1 is a vector of explanatory variables, β_i represents the coefficients of $the\ i^{th}$explanatory variables, β_0 is the intercept term.

The probability of being non-poor is:

$$(Y_i = 0) = \frac{1}{1 + e^{X_i\beta_i}} \tag{2}$$

To model the log odds of being multidimensionally poor, the logit transformation is applied:

$$\begin{aligned} logit\left(P\left(Y_i = 1\right)\right) &= \log\left(\frac{P\left(Y_i = 1\right)}{1 - P\left(Y_i = 1\right)}\right) \\ &= \log\left(\frac{P\left(Y_i = 1\right)}{P\left(Y_i = 0\right)}\right) \\ &= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p \end{aligned} \tag{3}$$

Where β_0 is the intercept term, $\beta_1, \beta_2, \cdots, \beta_p$ are the coefficients for each explanatory variable $X_1, X_2, \cdots\ X_P$. Positive β_i values indicate higher odds of being multidimensionally poor, while negative β_i values suggest lower odds.

Model selection and evaluation

For variable selection, both bivariate analyses (with a significance threshold of $p \leq 0.2$) and multivariate analyses (using $p \leq 0.1$) were conducted to ensure the inclusion of relevant variables in the final model [23–25]. The model's fit and performance were evaluated using various diagnostic tests, including the likelihood ratio test, the Hosmer-Lemeshow test, R-squared values, and the LOWESS smoother graph. These evaluations ensured the model's adequacy, validity, and adherence to key assumptions.

Additionally, to assess model selection, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used, which helped to identify the best-fitting model while minimizing overfitting [26, 27]. A significance level of $p < 0.05$ was considered statistically significant for identifying associations between the dependent and independent variables.

Results

Multidimensional poverty status of respondents

A survey of 628 rural households in the West Gojjam Zone reveals a high prevalence and intensity of multidimensional poverty. The multidimensional headcount ratio (H) is 93.95%, indicating that nearly 94% of individuals live in households experiencing deprivations in at least one-third of the weighted indicators. The intensity of multidimensional poverty (A) is 61.17%, reflecting the average proportion of deprivations experienced by the poor. The resulting adjusted headcount ratio, or Multidimensional Poverty Index (MPI), is 57.47%, signifying that the poor in the study area experience more than 57% of the total possible deprivations. These findings suggest that poverty in West Gojjam is not only widespread but also severe, with households commonly lacking access to

Table 1 Contribution of indicators to multidimensional poverty and multidimensional poverty status in West Gojjam zone

Poverty Dimension	Deprivation Indicator	% Contribution (*n*)	Total % Contribution (*n*)
Education Deprivation	Adult Education Deprivation	14.87% (93)	29.05% (182)
	Child Education Deprivation	14.18% (89)	
Health Deprivation	Child Mortality Deprivation	15.29% (96)	30.76% (193)
	Nutritional Deprivation	15.47% (97)	
Standard of Living Deprivation	Sanitation Deprivation	4.56% (29)	40.19% (252)
	Energy Deprivation	8.73% (55)	
	Clean Water Deprivation	5.48% (34)	
	Floor Deprivation	9.07% (57)	
	Asset Deprivation	5.43% (34)	
	Electricity Deprivation	6.93% (44)	
Multidimensional Poverty Status	Multidimensional headcount ratio (H)	93.95% (590)	
	Intensity of multidimensional poverty (A)	61.17%	
	Adjusted multidimensional headcount ratio (MPI)	57.47%	

Table 2 Model selection criteria and goodness-of-fit test results for determinants of multidimensional poverty in West Gojjam zone

Criterion	Value
Number of Observations	628
Number of Groups	10
Log-Likelihood of Null Model	-143.415
Log-Likelihood of Full Model	-27.777
Akaike Information Criterion	69.554
Bayesian Information Criterion	100.652
Hosmer-Lemeshow Chi-square	0.400
P-value	0.999

essential services such as adequate nutrition, electricity, improved sanitation, and clean drinking water (Table 1).

The primary contributors to multidimensional poverty in the West Gojjam Zone are the dimensions of the standard of living (40.14%), health (30.76%), and education (29.05%). Many households in the standard of living category live in substandard conditions, including mud floors, inadequate sanitation, and lack of electricity. They often depend on traditional fuels, such as animal dung, crop straw, and charcoal, for cooking due to limited access to modern energy sources. Moreover, many households must travel over 30 min to access clean water, exacerbating their deprivation.

In terms of health deprivation, nutritional deficiencies stand out as the most critical issue. 15.47% of the rural population fails to meet the World Health Organization's recommended daily intake of 2,100 kilocalories. Regarding education, adult education deprivation is particularly concerning, with 14.87% of adults lacking basic education. Furthermore, a significant number of children in the region are not attending school at the appropriate age, limiting their future opportunities and reinforcing the cycle of poverty.

Model diagnostics

The diagnostic evaluation of the binary logistic regression model assessing multidimensional poverty in the West Gojjam Zone confirms its robustness. The model's fit was compared using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), with the full model exhibiting the lowest values for both, indicating the best fit (Table 2).

The results of a LOWESS (Locally Weighted Scatterplot Smoothing) analysis examine the relationship between the predicted probability of deprivation (Pr(_H) and observed multidimensional deprivation. The X-axis represents the predicted probabilities, while the Y-axis shows the observed deprivation proportion. The blue dots indicate actual data points, and the red and green curves represent the smoothed relationship. The close alignment of the LOWESS curve with the diagonal line suggests a strong positive correlation, confirming a nearly linear relationship between predicted and observed deprivation. This supports the model's linearity assumption and its strong predictive power (Fig. 1).

The model showed a strong fit, with a pseudo-R-squared value of 80.60%, meaning that most of the variability in the model was explained by the selected variables. The Hosmer-Lemeshow test confirmed that the model fit the data well, with no significant evidence of poor fit. Additionally, Variance Inflation Factor (VIF) analysis indicated no multicollinearity issues, ensuring that the model's estimates are reliable (Table 3).

Factors associated with multidimensional poverty

The binary logistic regression analysis identified several key factors significantly influencing multidimensional poverty in the West Gojjam Zone. Land ownership, off-farm income, infrastructure, agricultural extension services, and access to credit emerged as crucial in reducing poverty. Conversely, older household heads remained significantly vulnerable, highlighting the need for targeted social protection strategies (Table 4).

Land ownership proved to be a particularly powerful determinant. For each additional hectare of land, the odds of experiencing multidimensional poverty declined by 99.6% (AOR = 0.004). This finding underscores the centrality of land as a productive asset in rural livelihoods. Secure land tenure and equitable land distribution are therefore essential for effective poverty alleviation. Policy interventions should prioritize land reform, enhance tenure security, and expand support services for smallholder farmers—including access to agricultural inputs, irrigation, and market linkages.

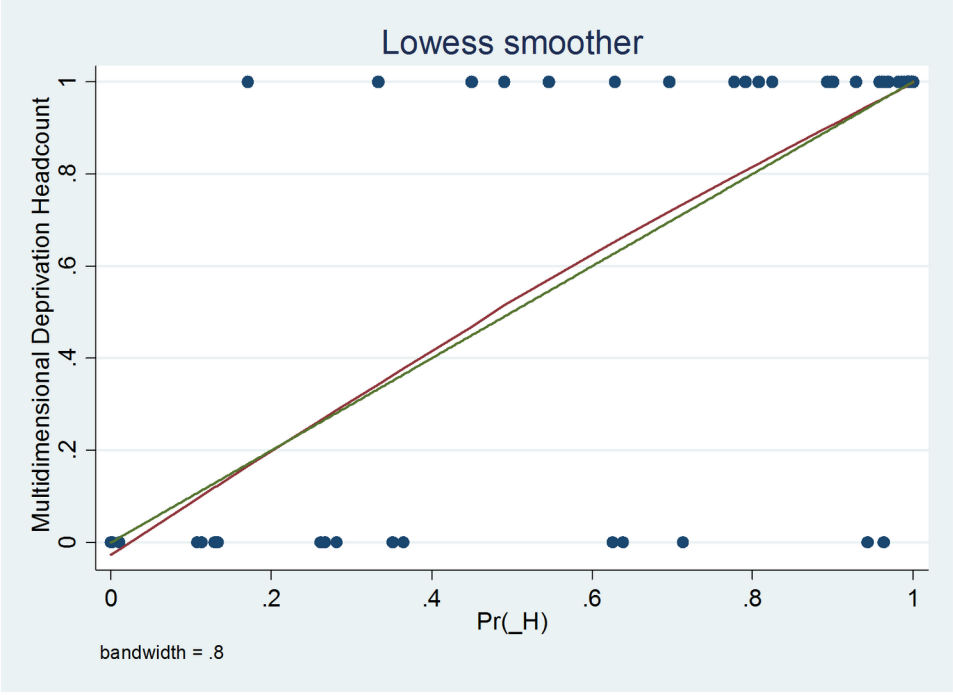

Fig. 1 Lowess smoother depicting odds ratio linearity

Table 3 Variance inflation factors for multicollinearity test

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Owned Land Size							
(2) Log Off-farm Income	1.075						
(3) Access to Roads	1.017	1.062					
(4) Frequency of agricultural extension service per year	1.061	1.075	1.036				
(5) Age of Household Heads (40–59 year)	1.001	1.000	1.002	1.000			
(6) Age of Household Heads (≥ 60 year)	1.003	1.017	1.022	1.000	1.001		
(7) Access to Loan Services	1.001	1.003	1.012	1.001	1.038	1.000	

Similarly, off-farm income demonstrated a strong inverse relationship with poverty. A 1% increase in off-farm income was associated with a 98.4% reduction in the likelihood of being multidimensionally poor (AOR = 0.016). This result emphasizes the importance of income diversification in enhancing household resilience and reducing dependency on rain-fed subsistence agriculture. Rural development strategies should thus promote entrepreneurship, vocational skills training, and access to microfinance services, thereby creating alternative and sustainable income streams.

Access to financial services was also significantly associated with lower poverty rates. Households with access to credit were 98.1% less likely to experience multidimensional poverty (AOR = 0.019), highlighting the role of financial inclusion in enabling investments in productivity and human capital. Expanding microfinance institutions, offering affordable and accessible credit, and promoting financial literacy—particularly in underserved areas—can empower rural households and foster inclusive economic growth.

Infrastructure, especially road accessibility, was another critical factor. Households with year-round road access were 99.9% less likely to be poor (AOR = 0.001). Improved transportation infrastructure enhances access to markets, employment, education, and health services. Therefore, investment in rural road networks is imperative for reducing geographic isolation, stimulating local economies, and improving overall well-being.

Agricultural extension services also played a significant role in poverty reduction. Each additional extension contact reduced the likelihood of being multidimensionally poor by 97.3% (AOR = 0.027). These services equip farmers with the knowledge, technologies, and skills necessary to improve productivity and incomes. Strengthening extension systems—through increased training, digital innovations, and broader outreach, particularly in remote areas—can greatly enhance the impact of agricultural interventions.

Table 4 Determinants of multidimensional poverty in West Gojjam Zone– binary logistic regression results

Variable	Categories	β	AOR	Standard Error	*P*-value
Owned Land Size	Continuous variable	-5.544	0.004	1.408	< 0.001
Log of off-farm Income	Continuous variable	-4.147	0.016	0.972	< 0.001
Access to Road	Yes	-6.269	0.001	1.894	0.001
	No (Ref)				
Frequency of agricultural extension service per year	Continuous variable	-3.598	0.027	1.252	0.004
Age of Household Heads	20–39(Ref)				
	40–59	1.200	3.320	1.250	0.252
	≥ 60	2.500	12.182	1.200	0.045
Access to Loan Services	Yes	-3.963	0.019	1.337	0.003
	No (Ref)				
Constant	Constant	4.735	113.857	2.064	0.003

Ref = reference group, β = Parameter Estimate, AOR= e^{β} , P-value=probability value

Demographic characteristics, particularly the age of the household head, were also significant. Households led by individuals aged 60 years and above were 12.2 times more likely to experience multidimensional poverty (AOR = 12.182). This reflects the heightened vulnerability of elderly individuals due to diminished earning capacity, higher health needs, and increased dependency. To address this, age-responsive policies—including social pensions, accessible healthcare, and community-based care programs—are essential to protect older adults from falling into or remaining in poverty.

Discussion

This study offers significant insights into multidimensional poverty among rural households in West Gojjam Zone, revealing both common and unique poverty dynamics within this region. While poverty is a pervasive issue globally, our findings highlight the distinctive factors that shape rural poverty in West Gojjam, including institutional weaknesses, environmental vulnerabilities, and limited access to basic services.

The high prevalence of multidimensional poverty, with 93.95% of rural households affected, is notably higher than poverty rates reported in other parts of Ethiopia, such as the Amhara region [3, 15], and urban centers like Nekemte City in Oromia [28]. This poverty rate mirrors patterns observed in rural South Asia, such as in Charsadda, Pakistan (84% poverty) and in India's BIMARU states [29, 30]. These regions face similar systemic challenges—insufficient infrastructure, limited access to public services, and a lack of employment opportunities—that contribute to high levels of multidimensional poverty.

The rural-urban divide in Ethiopia is stark, with West Gojjam's rural areas facing additional region-specific challenges like institutional fragility, political instability, and environmental stresses. These barriers impede the effectiveness of poverty reduction initiatives, deepening economic insecurity in rural households. In contrast, urban areas like Nekemte benefit from better infrastructure and services, contributing to lower poverty levels [28]. Political instability in rural areas further hampers efforts to address poverty, making it crucial to prioritize governance, infrastructure, and stability in poverty alleviation strategies.

Our analysis indicates that the most significant dimensions of poverty in West Gojjam are living standards (40.14%), health (30.76%), and education (29.05%). These findings resonate with global patterns, where poor living conditions, inadequate healthcare and limited educational opportunities are primary drivers of multidimensional poverty. Similar trends have been observed in Somalia, where living standards account for 45% of poverty [31], and in Jimma Zone, Ethiopia, where living conditions were the key deprivation factor for 83.5% of rural households [32]. These patterns suggest that improvements in infrastructure—such as roads, schools, and healthcare facilities—are critical for reducing poverty in rural areas.

Deprivations in health and education in West Gojjam are particularly severe when compared to other regions like South Asia and Iran [33, 34]. Rural households in West Gojjam face significant challenges in accessing quality healthcare and education due to underdeveloped public services. Informal healthcare providers and long distances to health centers, combined with inadequate educational facilities, contribute to these disparities. Addressing these gaps is essential for reducing multidimensional poverty and improving overall living standards in the region.

Land ownership was identified as a key factor in reducing multidimensional poverty. Our study found that each additional hectare of cultivated land decreases the likelihood of poverty by 99.6%. This aligns with earlier research emphasizing the importance of land access in alleviating poverty, particularly in agricultural communities [35]. In Ethiopia, land inequality remains a major driver of poverty, with smallholder farmers often lacking enough land to produce sufficient food and income [36]. Secure land tenure and more equitable land distribution are essential for improving food security and enabling households to invest in income-generating activities, thus reducing poverty. Similar findings in other Ethiopian

regions, such as Burji and Konso, underscore the importance of land access in alleviating poverty [37].

Access to credit emerged as a significant protective factor against multidimensional poverty in this study, with households accessing credit being 98.1% less likely to experience poverty. Credit facilitates investment in income-generating activities, enhances agricultural productivity, and improves access to essential services such as education and healthcare. Despite its benefits, access remains constrained by high transaction costs and limited financial literacy, particularly in rural areas. Addressing these barriers through affordable credit schemes and targeted financial education is essential for effective poverty reduction. These findings are consistent with prior research in the Gozamin district of East Gojjam [38] and evidence from other low- and middle-income countries [39].

This study reveals a strong inverse association between off-farm income and multidimensional poverty, with a 1% increase in off-farm income linked to a 98.4% reduction in the likelihood of being multidimensionally poor. Off-farm income serves as a critical source of financial stability, enabling rural households to access essential services such as education, healthcare, and adequate housing. It also enhances resilience by reducing dependence on agriculture, thereby buffering households against environmental and economic shocks. While concerns have been raised about the precarious nature of off-farm employment—often characterized by informality, low wages, and lack of social protection [40]—other studies underscore its positive contribution to poverty reduction [15]. Our findings align with previous research in Ethiopia poverty [41, 42], further emphasizing the importance of income diversification in rural development strategies. To maximize the benefits of off-farm income, targeted policy interventions are needed to promote vocational training, entrepreneurship, and access to secure and sustainable off-farm employment, particularly in underserved rural areas.

Infrastructure is a critical factor in poverty reduction. Road infrastructure is a critical factor in reducing multidimensional poverty. This study finds that households with year-round road access are 99.9% less likely to experience poverty (AOR = 0.001) compared to those without access. Roads provide vital connections to markets, agricultural inputs, healthcare, education, and off-farm employment opportunities, significantly boosting income, agricultural productivity, and overall living standards. Similarly, agricultural extension services contribute substantially to poverty reduction, with each additional service provided annually lowering the likelihood of poverty by 97.3% (AOR = 0.027). These services enhance agricultural productivity and improve access to essential services, reinforcing the positive cycle of poverty alleviation. Our findings align with previous research in Ethiopia and low-income contexts globally, which highlight the transformative impact of infrastructure on productivity and poverty reduction [15, 43, 44]. For instance, studies in the Amhara region show that road access significantly reduces multidimensional poverty [3]. However, regions like West Gojjam still face challenges due to underdeveloped road networks, limiting access to critical services and economic opportunities. Therefore, targeted investments in rural infrastructure, coupled with efforts to enhance education, healthcare, and livelihood diversification, are essential for fostering sustainable poverty reduction.

Finally, household heads aged 60 years and above are 12.2 times more likely to experience multidimensional poverty compared to younger individuals (AOR = 12.182). This finding is consistent with previous studies highlighting the increased vulnerability of older populations, particularly in rural areas, due to declining health, reduced productivity, and limited access to healthcare and education [15, 45, 46]. In many rural settings, older adults face financial insecurity, often lacking access to pensions or savings, which contributes to lower income and poor living conditions. These challenges call for the development of age-sensitive poverty alleviation policies, focusing on improved healthcare, social protection, and economic stability. Addressing the specific needs of older individuals, as evidenced by studies in East Gojjam [3, 15], is crucial for reducing their poverty risk and enhancing their quality of life.

This study has several limitations. The cross-sectional design restricts our ability to establish causality or track changes in poverty over time. Additionally, the reliance on self-reported data introduces the potential for recall bias, which may impact the accuracy of the findings, although validated instruments and strict confidentiality measures were used to mitigate this risk. Cross-sectional surveys also tend to offer limited insights into participants' experiences, often relying on a narrow set of questions that may oversimplify complex issues and fail to capture shifts in attitudes, behaviors, or socio-economic conditions over time. Moreover, the exclusion of marginalized groups, such as homeless individuals and refugees, who are disproportionately affected by poverty, may lead to an underestimation of poverty levels. To address these limitations, future research should incorporate longitudinal designs, such as panel data and time series analysis, include marginalized populations, and expand the geographical scope to better capture the evolving dynamics of poverty.

Conclusion and recommendations

Rural poverty remains a significant challenge in the West Gojjam Zone, with high multidimensional

poverty headcount ratios (93.95%), intensity (61.17%), and adjusted headcount (57.47%). These figures indicate severe poverty conditions, with living standards (40.14%) being the main contributor, followed by health (30.76%) and education (29.05%). The findings emphasize the urgent need for targeted interventions in these key sectors. Key factors such as agricultural extension services, off-farm income, access to credit, year-round road access, and land ownership are critical for reducing poverty. Additionally, older household heads are particularly vulnerable to multidimensional poverty.

Based on these findings, it is recommended that both government and non-governmental organizations strengthen and expand agricultural extension programs to provide farmers with up-to-date knowledge, skills, and technologies to boost productivity and income. The government should also promote diversified off-farm economic activities, including small businesses, vocational training, and entrepreneurship, particularly in rural Ethiopia. Enhancing access to credit and financial services, offering affordable and flexible loan products tailored to the needs of rural, multidimensionally poor households, is vital. Additionally, investing in rural road infrastructure will improve market access, reduce transportation costs, and connect remote households to essential services and opportunities. Facilitating fair and transparent land allocation and ensuring land tenure security are critical for improving agricultural productivity. Special attention must be given to older household heads, as they are more susceptible to multidimensional poverty due to limited labor capacity. Implementing targeted social protection programs, providing age-appropriate healthcare, and offering tailored skills training will significantly enhance their multidimensional poverty status. By combining these targeted interventions with broader, long-term strategies, the region can make substantial progress in reducing multidimensional poverty and fostering sustainable economic development.

Supplementary Information

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Supplementary Material 1

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Author contributions
YE and NG conceptualized the study, developed the research design, drafted the manuscript, and conducted the data analysis and interpretation. Both authors have reviewed and approved the final manuscript for submission.

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Data availability
The data sets analyzed in this study are available from the corresponding author upon reasonable request.

Declarations

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and adhered to National Research Ethics Review Guideline in Ethiopia. The study involved participants who were informed of their right to decline participation or terminate the interview, obtained written informed consent, and each household head confirmed their consent through a signed form. Confidentiality measures were maintained for all gathered information.

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